



Chen Elected as a Fellow of the AAAS

Long-Qing Chen, Hamer Professor of Materials Science and Engineering, is one of three Penn State faculty members named Fellow of the American Association for the Advancement of Science (AAAS) in 2018.

The AAAS is the world's largest general scientific society and publisher of the journal *Science*. Election as an AAAS Fellow is an honor bestowed upon members by their peers.

Chen was named for distinguished contributions to the development of the phase-field method and its applications to understanding, predicting, and designing materials microstructures and properties.

Chen is also among a group recognized in *Web of Science* for exceptional research performance demonstrated by the production of multiple highly-cited papers that rank in the top 1 percent by citations for field and year.

MatSE by the Numbers

- 29 tenure-line faculty
- 194 graduate students
- 384 undergraduate students
- 80 research associates/postdoctoral scholars
- \$15,750,066 annual research expenditures (2017-2018)

Creating Her Legacy

Susan Trolier-McKinstry

Election to the National Academy of Engineering (NAE) is among the highest professional distinctions accorded to an engineer. **Susan Trolier-McKinstry**, the Steward S. Flaschen Professor of Materials Science and Engineering, and professor of electrical engineering, is among eighty-six new members and eighteen foreign members elected for 2019.

"I owe this tremendous honor to many wonderful students and postdoctoral scholars over the years, as well as to supportive and collaborative faculty colleagues and mentors," said Trolier-McKinstry.

The NAE recognized her for the "development of thin film multilayer ceramic capacitors and piezoelectric microelectromechanical systems." Academy membership honors those who make outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to "the pioneering of new and developing fields of

technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

Trolier-McKinstry's main research interests include thin films for dielectric and piezoelectric applications. She is the director of Penn State's Nanofabrication Facility. She is a fellow of the American Ceramic Society, the Institute of Electrical and Electronics Engineers, and the Materials Research Society. She is also an academician of the World Academy of Ceramics.

Influenced by Newnham

"I am glad to be at Penn State," said Trolier-McKinstry, who has served in various roles during her time at Penn State. She started as a student, eventually earning her bachelor's, master's, and doctoral degrees from Penn State. She was an advisee of renowned materials scientist **Robert E. Newnham** for both her master's and doctoral theses.

see Trolier-McKinstry page 6



Susan Trolier-McKinstry (inset) leads the discussion with members of the Trolier-McKinstry Research Group as they provide feedback to a student presenting research findings. The group focuses primarily on thin film dielectric and piezoelectric materials. The group works to probe the fundamental mechanisms that control the magnitude of achievable properties and to integrate new materials into devices.



From the Department Head

I am delighted to share the wonderful news highlighted in this newsletter, starting with the well-deserved recognition of **Susan Trolier-McKinstry's** outstanding accomplishments in the field through her election to the National Academy of Engineering. It is especially significant that Trolier-McKinstry be so honored given her Penn State roots and contributions to the development and application of functional ceramic thin films, an area of historic strength for MatSE. I am also pleased to share that **Long-Qing Chen** is a 2018 Fellow of the American Association for Advancement of Science and that **Joan Redwing** received the 2019 Penn State Faculty Scholar Medal for her scholarly excellence. The newsletter also includes some recent research highlights from MatSE faculty.

MatSE was recognized for excellence in education leadership at both the graduate and undergraduate levels by Penn State. **Suzanne Mohney** was honored with the Graduate Program Chair Leadership Award and **Allen Kimel** was honored with the Undergraduate Program Leadership Award. These awards reflect our strong commitment to MatSE students, whose accomplishments are also summarized in this newsletter. It is exciting to report that new faculty member **John Mauro** was named MatSE faculty member of the year for 2018-19!

This was also a wonderful year for our alumni with **Delbert Day** receiving the Penn State Distinguished Alumni Award and **Daniel Lentz** receiving the Penn State Alumni Association Alumni Achievement Award. Our alumni spotlight this issue highlights **Dorothy Enright**, who received her M.S. in Ceramic Science and Engineering in 1948.

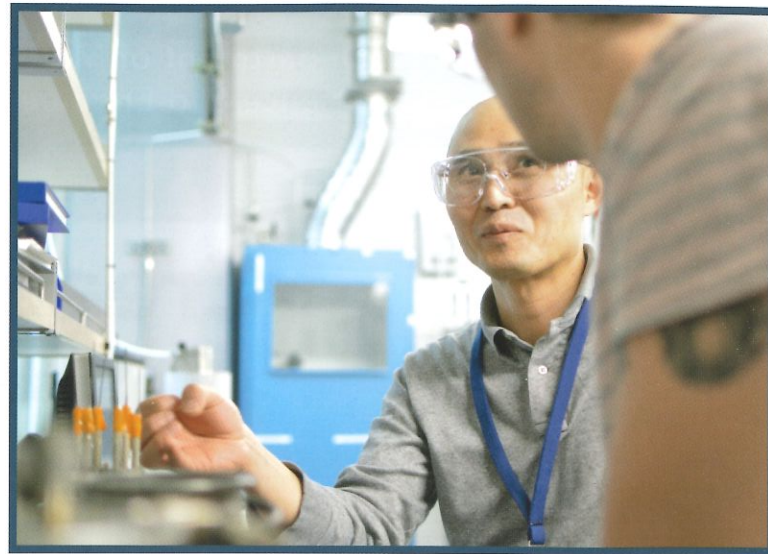
I invite you to like, follow, share, comment, and stay connected with us through Facebook, Twitter, YouTube, LinkedIn, and Instagram.

I always look forward to hearing from alumni and friends of MatSE. Please let me know when you will next be in State College.

Happy summer, everyone!

Susan B. Sinnott

Department Head and Professor of Materials Science and Engineering
sinnott@matse.psu.edu
814-863-3117



Hojong Kim, assistant professor of materials science and engineering, and **Timothy Lichtenstein**, a doctoral student, discuss the design of electrochemical cell for thermodynamic property measurements of rare-earth alloys for preliminary work on a project funded through the U.S. Department of Energy.

DOE Grant Aimed at Improving Process to Reduce Nuclear Fuel Waste

Researchers are using an \$800,000 grant from the U.S. Department of Energy to investigate a new approach for removing rare-earth fission products from a molten salt bath where used nuclear fuel is electrorefined for recycling uranium and minimizing nuclear waste.

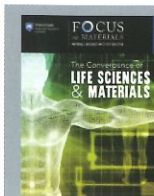
Hojong Kim, assistant professor of materials science and engineering, is using the grant toward efficient recovery of rare-earth elements using liquid metals.

"The electrorefining process is designed to separate the usable fraction of uranium metal, about 95 percent of the material, from the used nuclear fuel using a salt bath," Kim said. "However, in this process, rare-earth fission products are dissolved into the salt, accumulate over time, and must be removed to reuse the salt bath and minimize the generation of additional nuclear waste."

Current methods for removing rare-earth elements are not efficient because of the multivalent states and high chemical reactivity of rare-earth metals.

For example, the recovery efficiency of neodymium, the most common rare-earth fission product, is less than 50 percent, yet Kim has demonstrated that the recovery efficiency can be higher than 90 percent using liquid bismuth metal based on preliminary results in his laboratory.

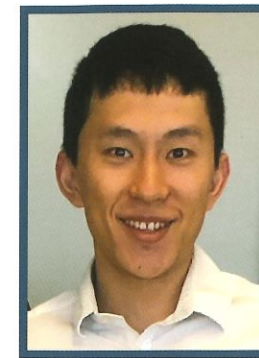
Kim will target three common rare-earth elements found in used nuclear fuel: neodymium, gadolinium, and samarium.



Interested in receiving more Penn State materials science research news? To subscribe to *Focus on Materials*, the MRI research publication, visit: mri.psu.edu/opt

Zhang Honored by Alumni Association

Kehao Zhang, doctoral student in materials science and engineering, is one of thirteen graduate students to receive the Penn State Alumni Association Dissertation Award, Distinguished Doctoral Scholar Medal in recognition of outstanding professional accomplishment and achievement in scholarly research.



Cestitke! Felicitações! Congratulations! Blahoželáme! Felicitări!

Redwing Receives Faculty Scholar Medal



Joan Redwing, professor of materials science and engineering, chemical engineering, and electrical engineering, is one of five faculty to receive the Faculty Scholar Medal for Outstanding Achievement for excellence in scholarship, research, and the arts. The award recognizes scholarly or creative excellence represented by a single contribution or a series of contributions around a coherent theme.

Gratulacije! Way to go! Gratulások! Tillykke! Selamat! Apsveicu!

Kimel Recognized with Undergraduate Program Leadership Award

R. Allen Kimel, associate teaching professor of materials science and engineering, is the recipient of Penn State's Undergraduate Program Leadership Award. The award recognizes a faculty member who has demonstrated exemplary leadership benefiting a Penn State undergraduate degree program.



Urime! Herzlichen Glückwunsch! Well done! Felicitaciones!

MatSE - Connect with MatSE - Connect with MatSE -
Connect with MatSE - Connect with MatSE - Connect with MatSE -
Connect with MatSE - Connect with MatSE - Connect with MatSE -
Subscribe
to stay connected with
Penn State MatSE!
Visit matse.psu.edu/subscribe
and we'll keep you informed.

Students Awarded NSF Fellowships

Five materials research students pursuing research-based master's and doctoral degrees received fellowships from the National Science Foundation Graduate Research Fellowship Program.

The program aims to support "outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics," according to NSF.

Materials research awardees:

- **Timothy Bowen**—advised by **Joshua Robinson**
- **Katy Gerace**—advised by **John Mauro**
- **Sarah Lowum**—advised by **Jon-Paul Maria**
- **Riccardo Torsi**—advised by **Joshua Robinson**
- **Everett Zofchak**—advised by **Robert Hickey**

Mohney Honored with Graduate Program Chair Leadership Award



Suzanne Mohney, professor of materials science and engineering and electrical engineering, is one of five recipients of the Penn State Graduate School Alumni Society Graduate Program Chair Leadership Award for exemplary leadership that benefits graduate students and faculty in an existing graduate program at the University.

While serving as chair of the MatSE Intercollege Graduate Degree Program

(IGDP) from 2013-2019, Mohney grew the graduate program, increased the quality and diversity of students, engaged faculty advisers, and expanded professional development opportunities available to students.

Since 2013 IGDP has grown 33 percent to an all-time high of more than 190 students, with about 90 percent pursuing a doctorate. Under Mohney's leadership, incoming students were more diverse and had improved entering grade-point averages.

Through increased recruiting and communication efforts, the number of students winning external fellowships has grown. In 2017, five continuing students were awarded federal fellowships, and seven students enrolled in IGDP in MatSE earned NSF fellowships.

This publication is available in alternative media on request. The University is committed to equal access to programs, facilities, admission and employment for all persons. It is the policy of the University to maintain an environment free of harassment and free of discrimination against any person because of age, race, color, ancestry, national origin, religion, creed, service in the uniformed services (as defined in state and federal law), veteran status, sex, sexual orientation, marital or family status, pregnancy, pregnancy-related conditions, physical or mental disability, gender, perceived gender, gender identity, genetic information or political ideas. Discriminatory conduct and harassment, as well as sexual misconduct and relationship violence, violates the dignity of individuals, impedes the realization of the University's educational mission, and will not be tolerated. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Office, The Pennsylvania State University, 328 Boucke Building, University Park, PA 16802-5901, Email: aao@psu.edu, Tel (814) 863-0471. U.Ed. EMS 20-04.

Day Honored with Distinguished Alumni Award

Penn State University's Highest Honor Presented to Alumni

Last year, thousands of people with inoperable liver cancer received hope from a treatment that involves injecting millions of microscopic, radioactive glass spheres near the tumor.

Others, suffering from chronic wounds, experienced relief thanks to new bioactive glass that bonds to skin and allows it a better chance to heal.

The co-inventor of these technologies, **Delbert E. Day '60g, '61g** ceramic science, was one of seven selected by the Penn State Board of Trustees to receive the Penn State Alumni Association's Distinguished Alumni Award, the University's highest honor presented to alumni.

"You are always surprised and flattered to receive this kind of recognition," said Day. "When it's the people who know you best, when they see something that in their opinion is an achievement, that means quite a bit."

Day, a prolific inventor and esteemed materials scientist, has published more than 400 papers on the properties, structures and uses of glass, and has received forty-seven U.S. and foreign patents. In 2017 the National Academy of Inventors named him a fellow.

But Day's career may have had a much different trajectory had he not answered

the phone one day nearly sixty-one years ago.

A life-changing phone call

On the other line was **Guy E. Rindone**, then a faculty member of the Department of Ceramic Science and Engineering, the predecessor to the Department of Materials Science and Engineering, who would go on to have a long career at Penn State, including more than a decade as department head.

"My eyes were opened to a different kind of school. I've always been very proud of the fact that I had the opportunity to go to Penn State. I never expected that type of opportunity. It was just kind of like a great streak of good luck."

—Delbert Day

Rindone remembered Day from a ceramics conference in Pittsburgh months before and inquired whether Day had considered attending graduate school.

Day, who was weeks away from completing his undergraduate degree at the Missouri School of Mines and Metallurgy, intended to leave academia and pursue a career in industry, but something about the phone call intrigued him enough that he agreed to visit Penn State.

"Here was a college professor who didn't know me from Adam, but he had heard something I said in this student speaking contest, and he had remembered that and took his time and called me up," Day said. "I thought, a person like that, maybe you should pay some attention to him."

Day said his time studying at Penn State and his work with Rindone prepared him

for a long career creating glasses for uses in the healthcare, electronics, transportation, aerospace, and chemical industries.

"My eyes were opened to a different kind of school," Day said. "I've always been very proud of the fact that I had the opportunity to go to Penn State. I never expected that type of opportunity. It was just kind of like a great streak of good luck."

Using glass to improve lives

After earning his master's and doctorate at Penn State, Day became a faculty member at the Missouri University of Science and Technology, where he is now Curators' Distinguished Professor Emeritus of Materials Science and Engineering.

Soon after joining the faculty, Day and his students had the opportunity to help treat patients with inoperable liver cancer using glass microspheres.

The technology, marketed today under the brand name TheraSphere, allows doctors to inject the radioactive glass spheres into the blood stream that feeds the tumor, in a unique form of radiation therapy.

"My students took to this project, and I didn't have to motivate them," Day said. "When I saw the reaction in those students, I said, 'you know, maybe we should just concentrate on working on problems that have direct application.' From that point on, we looked to develop glasses that could help a person in some way."

Day and a student later created bioactive glass fibers to help treat chronic wounds, the kinds that often affect the elderly and those suffering from diabetes and other health issues. Bioactive glasses have also been used for bone repair and in dental applications.

"I think when you have the opportunity to actually help someone, and you are able to see it materialize, being a part of that would excite anyone," Day said. "Or at least it should."



Penn State President Eric Barron congratulates alumna **Delbert Day**, inventor and materials scientist, as he receives his 2019 Distinguished Alumni Award, the University's highest honor presented to alumni.

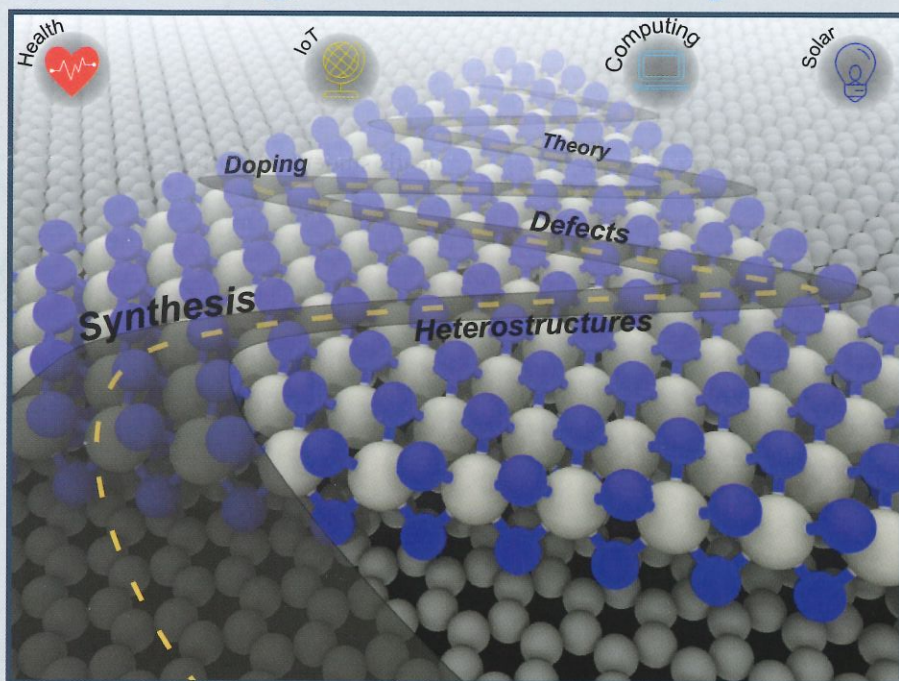


Mauro Named MatSE Faculty Member of the Year
The MatSE Faculty Member of the Year Award was presented to **John Mauro**, professor of materials science and engineering, during the MatSE 2019 Spring Awards Banquet.



Van Ackeren Named MatSE Alumnus of the Year
The MatSE Alumnus of the Year Award was presented to **James Van Ackeren** '75, '77g, who received degrees in ceramic science, during the MatSE 2019 Spring Awards Banquet. He is a past-president and former member of MatSE's External Advisory Board.

Creating a Roadmap for 2-D Materials



A roadmap for 2-D materials explores the challenges of synthesizing electronic grade materials.

An invited article by a large group of materials scientists in the journal *2D Materials* provides a roadmap for the synthesis of electronic-grade 2-D materials for future electronic and sensing applications. Led by Penn State, with contributions from five additional universities and national laboratories, the roadmap addresses the grand challenges in 2-D materials with useful electronic or photonic properties, and the outlook for U.S. advances in the field.

Technical roadmaps, such as the International Technology Roadmap for Semiconductors (ITRS), first published in 1998, serve as guides for future advances in a particular field and provide a means for organizations to plan for investments in new technology.

"This article is a review of where we currently are in regard to the synthesis of 2-D materials and our thoughts on the top research priorities that need to be

addressed to achieve electronic grade 2-D materials," said Joshua Robinson, associate professor of materials science and engineering, whose Ph.D. students Natalie Briggs and Shruti Subramanian are co-lead authors on the report titled "A Roadmap for Electronic Grade 2-Dimensional Materials."

"To put our roadmap together, we reached out to experts in various subfields, such as different synthesis approaches, defect engineering, and computational theory," said Briggs of the two-year project. "We asked them to talk about the key fundamental challenges and the steps required to address these challenges in their area of expertise."



Ph.D. students, **Natalie Briggs** and **Shruti Subramanian** are co-lead authors of a 2-D roadmap published in the journal *2D Materials*.

Lentz Earns Alumni Achievement Award

Daniel Lentz '10g is one of fifteen recipients of the 2019 Penn State Alumni Association's Alumni Achievement Award, presented annually to prominent young alumni.

"Receiving the Alumni Achievement Award is truly humbling," said Lentz. "I'm appreciative and excited to come back to Penn State and accept this honor."

Lentz is a product development specialist at the 3M Company, where he's helped make technology improvements in optical films, roll-to-roll processing, and abrasives. He is co-author on two granted and eleven published or pending patents.

He currently works in the company's coated abrasives department, developing the next generation of sand paper, orbital sanding discs, and related products.

"This work is something I feel can actually benefit someone," Lentz said. "If I can make something vibrate less, require

less force so someone doesn't have a backache after working eight hours when they go home to their kids, that makes me feel good. In my position, I'm using the skills I've honed and I'm fortunate to be able to do something good."

At Penn State, Lentz studied polymer physics and polymer chemistry. He has worked on diverse projects at 3M, establishing himself as an expert in chemical etching and precision patterning, and serving in leadership roles within the company.

"A theme in my career is I've worked on these projects that are seemingly not related, but when you look at the fundamental science, there are a lot of commonalities," he said. "Fundamentally, in materials science you are really trying to understand the kinetics, the motion going on at the molecular scale, and how to leverage that to make a useful system."

"Penn State prepares its students very



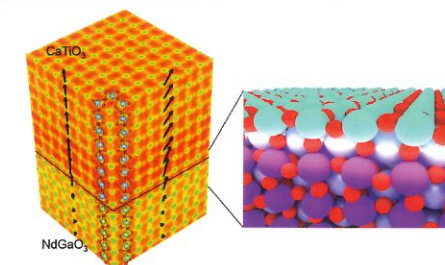
well," Lentz said. "Not just in the technical skills, which are important, but also in the soft skills; like understanding how to collaborate, function in high-performance environments, and how to think critically."

He remains active in the University community, serving as the head of 3M's Penn State University Relations team. In that role, he advocates for Penn State programs, sponsors multiple professors for 3M's Non-Tenured Faculty Award, and leads student recruiting efforts.

A 3-D Imaging Technique Unlocks Properties of Perovskite Crystals

A team of materials scientists from Penn State, Cornell, and Argonne National Laboratory have, for the first time, visualized the 3-D atomic and electron density structure of the most complex perovskite crystal structure system decoded to date. Perovskites are minerals that are of interest as electrical insulators, semiconductors, metals, or superconductors, depending on the arrangement of their atoms and electrons.

Perovskite crystals have an unusual grouping of oxygen atoms that form an octahedron, an eight-sided polygon. This arrangement of oxygen atoms acts like a cage that can hold a large number of the elemental atoms in the periodic table. Additionally, other atoms can be fixed to the corners of a cube outside of the cage at precise locations to alter the material's properties, for instance, in changing a metal into an insulator, or a non-magnet into a ferromagnet.



A reconstruction of a perovskite crystal (CaTiO_3) grown on a similar perovskite substrate (NdGaO_3) showing electron density and oxygen octahedral tilt. The insert shows an artist's conception of the interface between substrate and film.

"We have been able to see atoms for quite some time, but not map them and their electron distribution in space in a crystal in three dimensions," said **Venkat Gopalan**, professor of materials science and physics, Penn State. "If we can see not just where atomic nuclei are located in space, but also how their electron clouds are shared, that will tell us basically everything we need to know about the material in order to infer its properties."

Susan Sinnott, department head and professor of materials science and engineering at Penn State, performed density functional theory calculations that provided insights into the experimental data, explaining how materials properties change with the alignment or tilting of the perovskite oxygen cages.

The team also validated their advanced Coherent Bragg Rod Analysis (COBRA) technique against multiple images of their material using the powerful Titan transmission electron microscope in the Materials Research Institute at Penn State.

Their work, titled "Three-dimensional atomic scale electron density reconstruction of octahedral tilt epitaxy in functional perovskites," was published in the journal *Nature Communications*.

Trolier-McKinstry's work mimics Newnham's research in many ways, and she acknowledges his training has massively influenced her career. Following Newnham, her research also focuses on dielectrics, piezoelectrics, and their miniaturization for applications in sensors, medical imaging, and more.

"I also joke: Newnham was six feet, five inches tall—I'm not quite five feet tall," said Trolier-McKinstry. "So, for whatever reason, when he saw me, the first program he assigned me to was on miniaturization," she said with a laugh.

An expert lecturer and adviser, Newnham was also a leading researcher in the field. He invented the composite piezoelectric transducer that makes modern ultrasound scans possible and received several awards like the Franklin Medal in Electrical Engineering, one of the highest distinctions in science.

"He was amazing, both as an educator and a scientist," said Trolier-McKinstry. "He influenced not just me, but whole generations of people."



Susan Trolier-McKinstry with Robert E. Newnham

Honoring Newnham's legacy

When Newnham approached Trolier-McKinstry with the goal of collaborating on a textbook, she gladly obliged. It was agreed that Newnham would write the content and Trolier-McKinstry would supply the figures.

Unfortunately, during the writing process Newnham fell ill, but Trolier-McKinstry promised to honor Newnham's legacy by finishing the book for him. She worked closely with Newnham's children, Randy and Rosemary, and integrated Newnham's drafted chapters into the text.

A master of crafting new ways to think about materials, Newnham had an

aptitude for creating understandable, versatile analogies, and visualizations that distinguished him as both a researcher and a professor. "His goal, and my goal, was to transfer that kind of intuitive thinking forward," said Trolier-McKinstry.

"Having Dr. Trolier-McKinstry as a role model in the department goes a long way in showing both women and men what they can achieve with their Penn State education and a lot of hard work."

—Ana Isabel de la Fuente Duran, undergraduate student

The fulfillment of her promise is the textbook *Materials Engineering: Bonding, Structure, and Structure-Property Relationships*, published December 2017.

The book is intended to fill a niche in materials science educational material while serving a wide audience: undergraduates, graduate students, and even professionals in the field.

"There simply was no text in existing literature that covered both crystal structure and structure-property relations well," said Trolier-McKinstry.

Another issue the textbook addresses is inconsistency in notation and nomenclature. Without a textbook that puts information in one place, educators resort to teaching from different sources, which can create confusion.

Making her own impact

Trolier-McKinstry is making her own impact on students and Penn State as a whole. "It's inspiring and encouraging to see everything Trolier-McKinstry has been able to achieve with her career up

close. She's an incredible professor and a high-achieving scientist," said Ana Isabel de la Fuente Duran, MatSE undergraduate student.

De la Fuente Duran, a founding member and president of the newly-formed student organization, Women in Materials Science (WiMS), said, "Having Trolier-McKinstry as a role model in the department goes a long way in showing both women and men what they can achieve with their Penn State education and a lot of hard work. Personally, I find her inspiring because she was one of very few women in the field when she started her education and career, but she did not let that stop her from going above and beyond. As someone who is a minority, it's great to see that she has been able to achieve amazing things even when the odds may have been stacked against her."

Alumni - Students - Faculty - Staff
SAVE-THE-DATE
MatSE
Ice Cream
Social

Fri., Sept. 6, 2019

11:00 a.m.–1:00 p.m.

West Halls Lawn
 (across from Steidle Building)

Rain location: Steidle Atrium



Department of Materials Science and Engineering
The Pennsylvania State University
221 Steidle Building
University Park, PA 16802

Let's keep in touch!

Visit matse.psu.edu/subscribe and follow us on:



Alumni Spotlight: Dorothy (Pate) Enright, '48g Ceramic Science

Hometown: Houston, Texas

My favorite job was ... every job I held was my favorite while holding it. Except the two jobs that I left very soon after arriving—realizing that I was in the wrong place at that time.

Highlight of my career was ... receiving the Meritorious Civilian Service Award from the U.S. Navy for the study of intermetallic compounds in 1995 which is the third highest Naval civilian award. In 2004, I received the Henry K. Roos Award—Volunteer of the Year from The Museum of Fine Arts, Houston, for assisting in the archive, retail, and library departments. I also presented papers at national and international conferences. The first one was at the American Ceramic Society Meeting in 1949.

I chose Penn State because ... I was advised that it was the best school for studying ceramics and was offered a graduate assistantship.

When I was 5 years old I wanted to be ... six years old so I could go to school.

You might be surprised to know that ... I've never eaten a hot dog, and I plan to keep it that way.

The biggest influence (positive or negative) on my life was ... I do not think there was a "biggest influence" in my life. Family, friends, mentors, managers, people in general, and events contributed to my well-being.

My words of wisdom to current students are ... to be a good student, complete assignments on time, attend classes on time, ask questions, and begin developing people skills through interaction with classmates and professors. Remember you are at Penn State to learn.

My advice to graduating students is to ... consider the diploma you receive as a passport. It indicates that you have

learned many facts, theories, and skills in your particular field of study. It is now your responsibility to apply them in the real world. You are now on a new learning curve, and you should stay on it for a lifetime. Have a delightful journey!

